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which in forest, field or fen, invite the search of the botanist and the lover of nature.

Perhaps subsequent articles may give some notes upon the flowers of later spring, summer and autumn, with a floral calendar, and possibly an enumeration of some plants and shrubs well worthy of a place in garden or shrubbery, but hitherto neglected. If this shall succeed in leading any to a closer study of nature's beauty, and the goodness and glory of the Creator, its object will be answered.

THE FRESH-WATER AQUARIUM.

BY C. B. BRIGHAM.

THE art of preserving water animals alive and in good condition, as pets or as objects of study, is not of recent date; but the principles of what is now commonly known as the aquarium, were not until lately brought into general notice. The Romans had their tanks of game fish, the English and French gardeners their vessels for the growth of tender water-lilies or other valuable aquatic plants, yet the happy thought of uniting the two,—fishes and plants,—so that the one should balance the other, each aiding in the others support, making withal a collection of such proportions as to be conveniently kept indoors, is the production of comparatively late years.

Dr. Johnstone, of Liverpool, has the reputation of having been the first to apply practically the principles of the aquarium; he made experiments with the *Corallina officinalis*, Starfish, *Confervæ*, and some small plants of the *Ulva latissima*, and found that they flourished for eight weeks without being disturbed; this led him to try some fresh-water fishes and larvæ, and they succeeded even better than the salt-water specimens. Since then Gosse, Hibberd, Warrington

and others of England, and the late Mr. Cotting, of Boston, have done much towards forwarding the interests of the aquarium. The whole secret of the success of the aquarium lies in the exactness with which we imitate nature in arranging and disposing our collections; but let us understand first of all that what is meant by the term an aquarium is a collection of water plants and animals, so arranged in suitable ratio that it shall be perfectly self-supporting. We do not expect, then, that the water will have to be changed until after long periods, if at all; the plants and animals should flourish as well as if in their native locality.

How then is this balance of forces to be attained? This leads us to examine the philosophy of the aquarium, which is simply this: The element in water which the fishes live on by breathing is free oxygen, which, as the water is fanned through the gills or lungs of the fish, comes in contact with the walls of its vessels, and arterializes the blood; all water contains a certain amount of this oxygen, sufficient to keep a fish alive for a short time, but if no means are taken to create a fresh supply, it will become exhausted sooner or later, and an escape of carbonic acid will render the water poisonous to the fish. In plants on the other hand we have an agent taking up the carbonic acid in the water, and resolving it into carbon and oxygen, the former of which it converts into its substance, while it expels the latter from every part of its tissue, especially from the leaves in the form of minute bubbles, plainly seen in healthy plants, and so often compared to drops of quicksilver in appearance. It is true that plants absorb oxygen also as fishes do, but they give out so much more than they absorb, that this is of slight account.

Another oxygen producing agent, as was shown by Liebig, is to be found in the almost microscopic forms of animal life which abound in water which has stood for some time exposed to the air. These animalculæ seem to form another link in the chain which binds together all kinds of animal

life of higher or lower order, however apparently diverse they may be. This extra supply of oxygen adds greatly to the support of the aquarium, and is no doubt the reason why a large number of fishes can be supported with a seemingly small proportion of plants. It would indeed be an interesting experiment to try, were we to place a small fish in a large tank, and see if, from the oxygen of these infusorial animalculæ alone, life could be sustained.

It must be the aim of him who wishes to establish an aquarium to see that this balance of plants and fishes is effected, for it is indispensable. Starting then with some idea of what we wish to accomplish, the first inquiry is about the kind of tank we are to use. This is an affair of more than mere fancy, convenience, or economy, for it is important for the growth of many plants that they should have the greatest amount of light possible, and this is especially true with fresh-water plants; so that where a washbowl or a tub would make an excellent tank for a salt-water collection, the same might fail of success in one with fresh-water. Besides there are many specimens which we wish to examine sideways, and obtain that view which it is not possible to have in nature, namely, that of a vertical section of a pond. The requirements of a good vessel or tank for an aquarial collection, are strength and sufficient transparency; these we have in a moderate degree in the inverted bell-glasses, or cake covers, of confectioners. If, however, the glass becomes cracked and broken from any cause, and it is surprising how easily it is broken, the whole collection of specimens is in great danger of being lost, especially if the accident happen in the night-time. Another disadvantage which the cake covers have is, that through them the specimens are sometimes magnified, and irregularly too, so that what has been put into the tank as a very small and finely shaped fish, in an instant becomes a giant more or less deformed. This kind of tank is the usual one adopted by those who are making an aquarial collection for the first time, and it

answers many purposes admirably ; it is sufficiently transparent, moderately strong, and quite cheap. One having a diameter of twelve and a half inches, with a depth of eight inches, and of good thickness, can be bought for two dollars and a half ; the knob on the top will prevent its standing steadily, and to obviate this difficulty a stand can easily be turned from a block of wood, with a hole cut in the centre large enough to admit the knob, and allow the bottom of the glass to rest upon it as a support. If properly taken care of, a tank of this sort will last for years, and be a great comfort to its possessor, but an untimely accident will before long induce him to try something more substantial.

Perhaps the best tank for the aquarium in use is what is called a rectangular tank, having the four sides of glass, and the base of some hard material such as stone, iron or wood. The glass is held in place, and supported at the four corners by as many pillars of iron or wood, which are held together on top by strips of a similar material connecting them. Of the three materials for the base and pillars, iron is by far the best for a fresh-water tank, if we can have but one material alone ; it is lighter than stone, and the little it rusts from time to time does not amount to anything ; the water does not ooze through it as it does through some kinds of stone, and it does not warp, as wood is so apt to do if the tank is left without water for a length of time. To prevent rusting a layer of cement may be spread on the bottom of the tank inside, and a plate of thick strong glass placed upon it ; and in the same way a narrow strip of glass can be cemented to each of the pillars, so that the iron shall be prevented from coming in contact with the water at every point. A tank, having a base of slate and pillars of iron protected by glass, as just explained, is the best kind of a tank to own, as it can be used for either salt or fresh water as we require. The shape of a tank, too, is of some importance, that of a double cube being the best for this reason, that it allows more of a clear surface on the long sides for inspection after the rock-

work and plants are introduced, than a tank whose shape is square ; it also gives a better chance for the light to strike upon every point inside.

The facilities for procuring tanks already made are so great nowadays, that while once it was an object to know how to construct a tank for one's self, now one has only to make a choice from several patterns. The most important thing to look after in selecting a tank, next to its material and shape, is the kind of cement which has been used ; all sorts of putty are to be rejected as worthless ; if we cannot be sure that the cement is good and not injurious to fishes, a few weeks trial, or even less, will convince us of its value. Another point to be attended to, is that the cement be quite hard before the tank is filled with water, as there are some kinds of cement used that never harden ; of course, in these cases there is danger of having a leaky tank to contend with.

Of the other kinds of tanks, either those made wholly of clay, or of glass, or those with one side at an angle of 50° with the base, so as to form a beach, after the pattern of the Warrington tank, or those with all the sides of slate, in imitation of a rock pool, or those of an oval or hexagonal shape, each has its advocates. Some tanks have been lately made in New York, with the base and pillars of a composition which is silver-plated ; they are wonderfully light and beautiful, but there seem to be doubts as to their durability. More or less ornament can be displayed on the pillars and base of the tank, according to the taste of the owner, but it seems as if simplicity and neatness were full as requisite here as elsewhere, and that the ornament of the tank should be the collection inside. As to the size of the tank, it very much depends on the place one has to put it in. These three sizes I have found from experience very useful :

No. 1, Length, 18 in. ; depth, $10\frac{1}{2}$ in ; width, 12 in.

No. 2, Length, 24 in. ; depth, 14 in. ; width, $14\frac{1}{2}$ in.

No. 3, Length, 28 in. ; depth, $13\frac{1}{2}$ in. ; width, 13 in.

Number three is, perhaps, the best size of all, and it is by

far the prettiest shape. Tanks can be purchased, generally, at the bird or plant stores of large cities; the prices range from six dollars upwards. Sometimes a stand for the tank is made in connection with it, or of a similar material. It is well to remember in selecting a stand, the enormous weight which it will have to bear when the tank is filled with stones and water.— *To be continued.*

HINTS ON TAXIDERMY.

BY C. A. WALKER.

Equipment for the travelling collector.—The travelling collector should equip himself with a double-barrelled gun (and a rifle when large animals are sought for), ammunition, including shot for small birds and mammals (numbers 2, 6, 8, and 10,—the latter should never be omitted); dissecting instruments, scissors, needles and thread, preservative drugs and preparations, and alcohol about 80 per cent. in strength; tin cans of various sizes for containing alcoholic specimens, since glass bottles and jars are liable to be broken during transportation; cotton and tow for stuffing the skins of birds and mammals; fishing lines and hooks, casting net, a seine for catching fishes in small streams, the two ends of which should be secured to long wooden handles, which are held in the hands of two persons upon opposite banks; in this position it can be drawn both up and down the stream. He should also carry with him a geological hammer and steel chisels for collecting fossils and rock specimens, and small pocket vials and cork-lined boxes for insects.

Preservatives.—Common powdered arsenic should be employed for skins to be mounted at once, instead of arsenical soap, as it has a tendency to dry them quickly. It may be applied dry, or mixed with alcohol until it is of the consist-